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(71) Applicant
Lester William Branning, 10075 West Bay Street, Largo, Florida, United States of America
(72) Inventor
Lester William Branning
(74) Agents
A. A. Thornton & Co., Northumberland House, 303—306 High Holborn, London WC1V 7LE

(54) **Portable Computing-printing Device**

(57) A portable computer-printer-recorder is capable of retrieving earlier recorded information, receiving new information, computing charges therefrom, printing a bill or invoice on the premises, and recording this new information and the charges for later retrieval. It may weigh less than 9 pounds and occupy a space of approximately 1/6 of a cubic foot. Communication to and from the computer is effected through a hand-held terminal which allows information to be entered into the computer and recorded information to be regenerated back to the operator. Also contained within the body of the manpack computer is a printing unit capable of printing information in various formats suitable for being left on the premises as the customer's bill.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

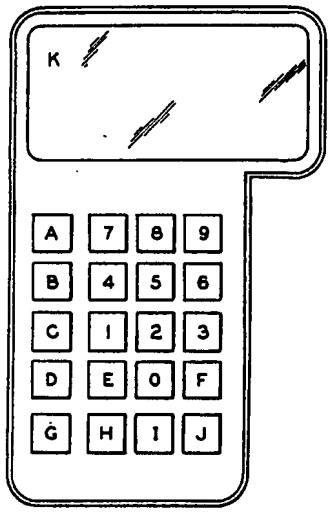


FIG.1

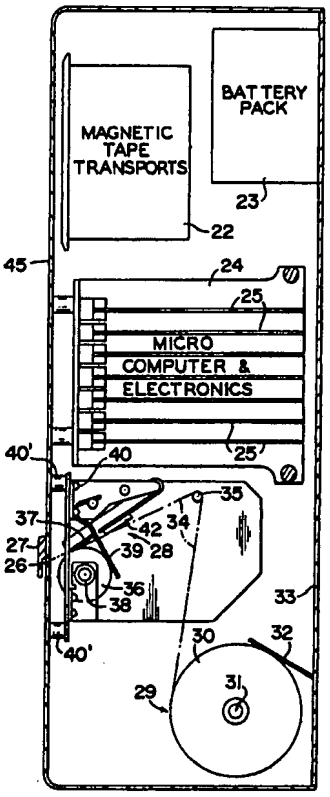


FIG.3

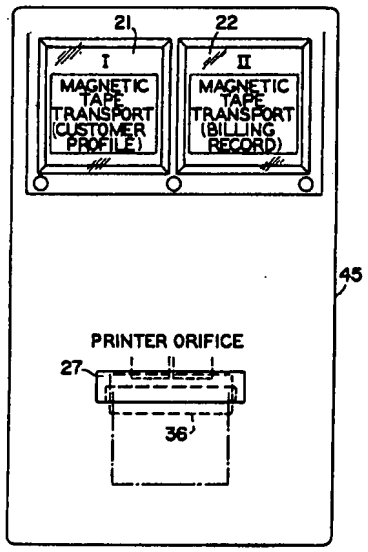


FIG.2

FIG. 4

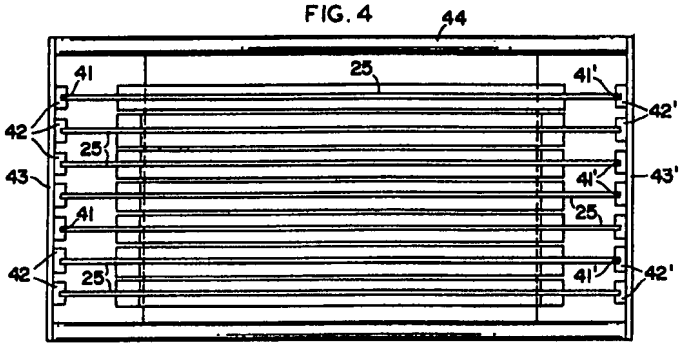
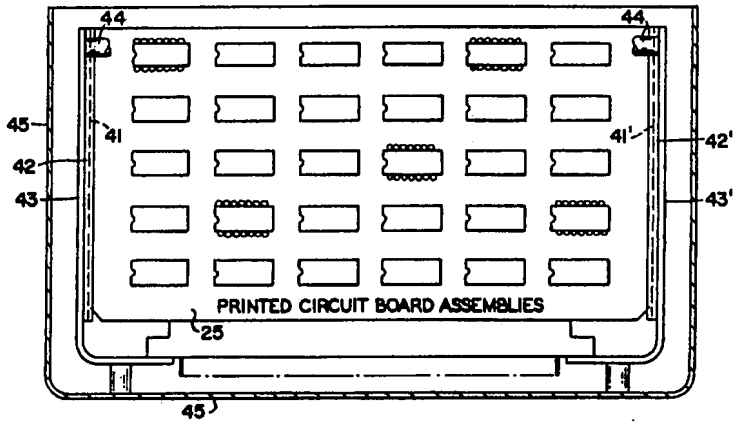


FIG. 5



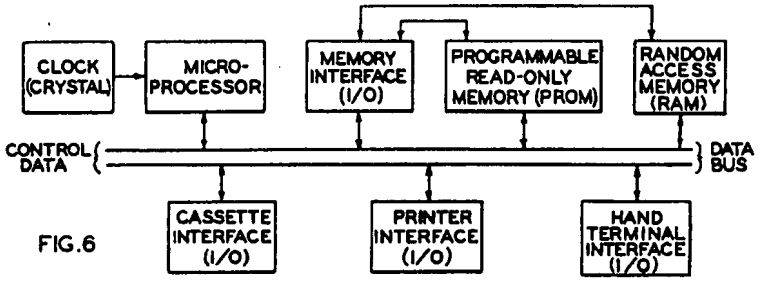


FIG.6

FIG. 7

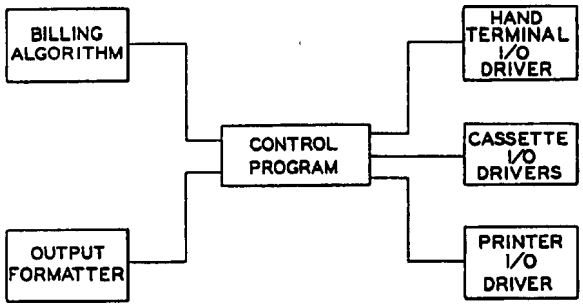


FIG. 8

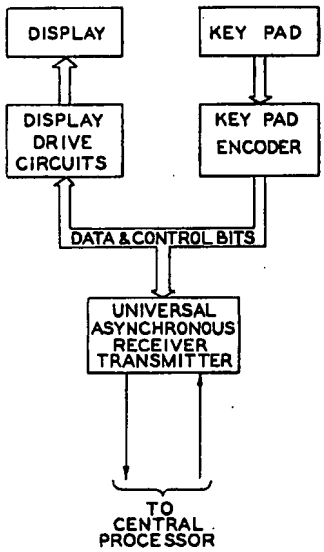
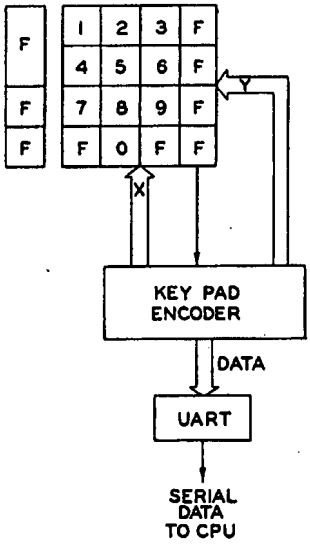


FIG. 9



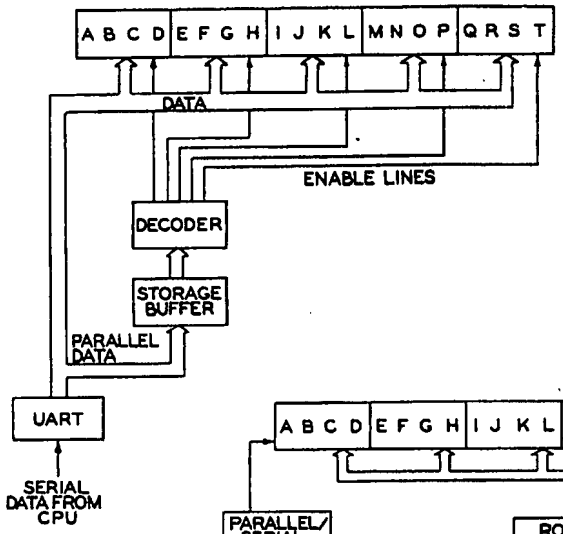

A B C D E F G H I J K L M N O P Q R S T
DATA
ENABLE LINES
DECODER
STORAGE BUFFER
PARALLEL DATA
UART
SERIAL DATA FROM CPU

FIG.10

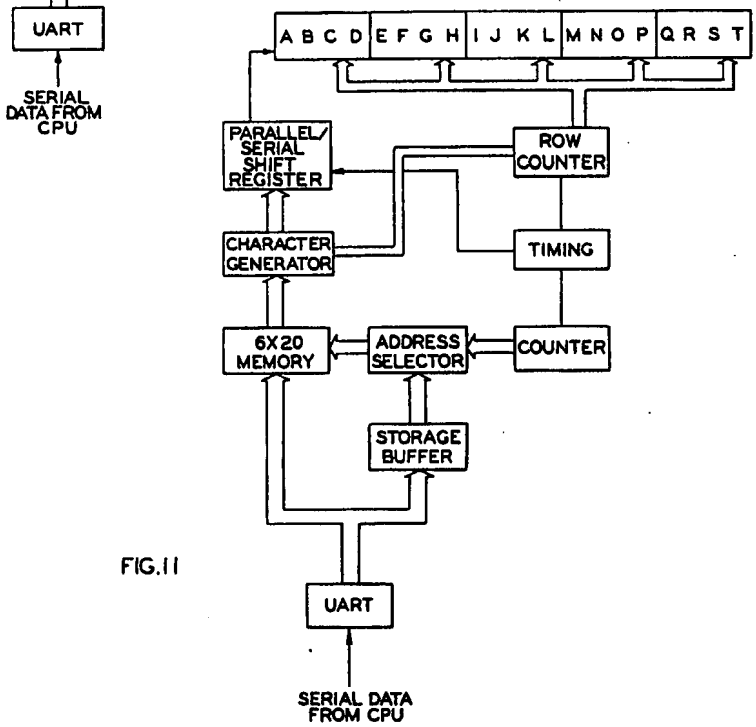
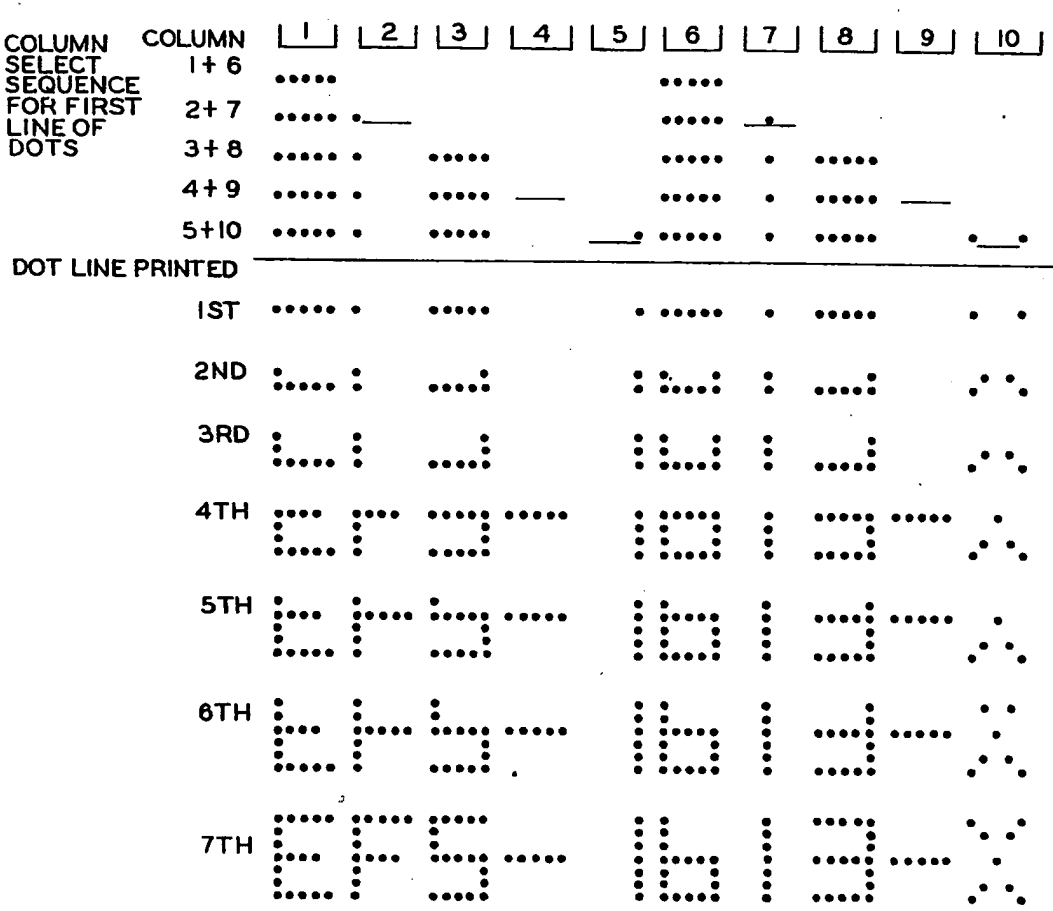

A B C D E F G H I J K L M N O P Q R S T
PARALLEL/ SERIAL SHIFT REGISTER
ROW COUNTER
CHARACTER GENERATOR
TIMING
6X20 MEMORY
ADDRESS SELECTOR
COUNTER
STORAGE BUFFER
UART
SERIAL DATA FROM CPU

FIG.11

10 CHARACTER PRINT HEAD PRINTING SEQUENCE



EXAMPLE 1

THIS SHOWS THE INTERLACING COLUMN PRINT METHOD FOR A LINE OF DOTS. EXAMPLE USES LINE ONE OF THE BELOW SHOWN COMBINATION OF LETTERS AND NUMBERS.

EXAMPLE 2

SHOWS A TYPICAL SEQUENCE OF THE 7 DOT LINES BEING PRINTED TO MAKE A SINGLE CHARACTER LINE.

FIG. 12

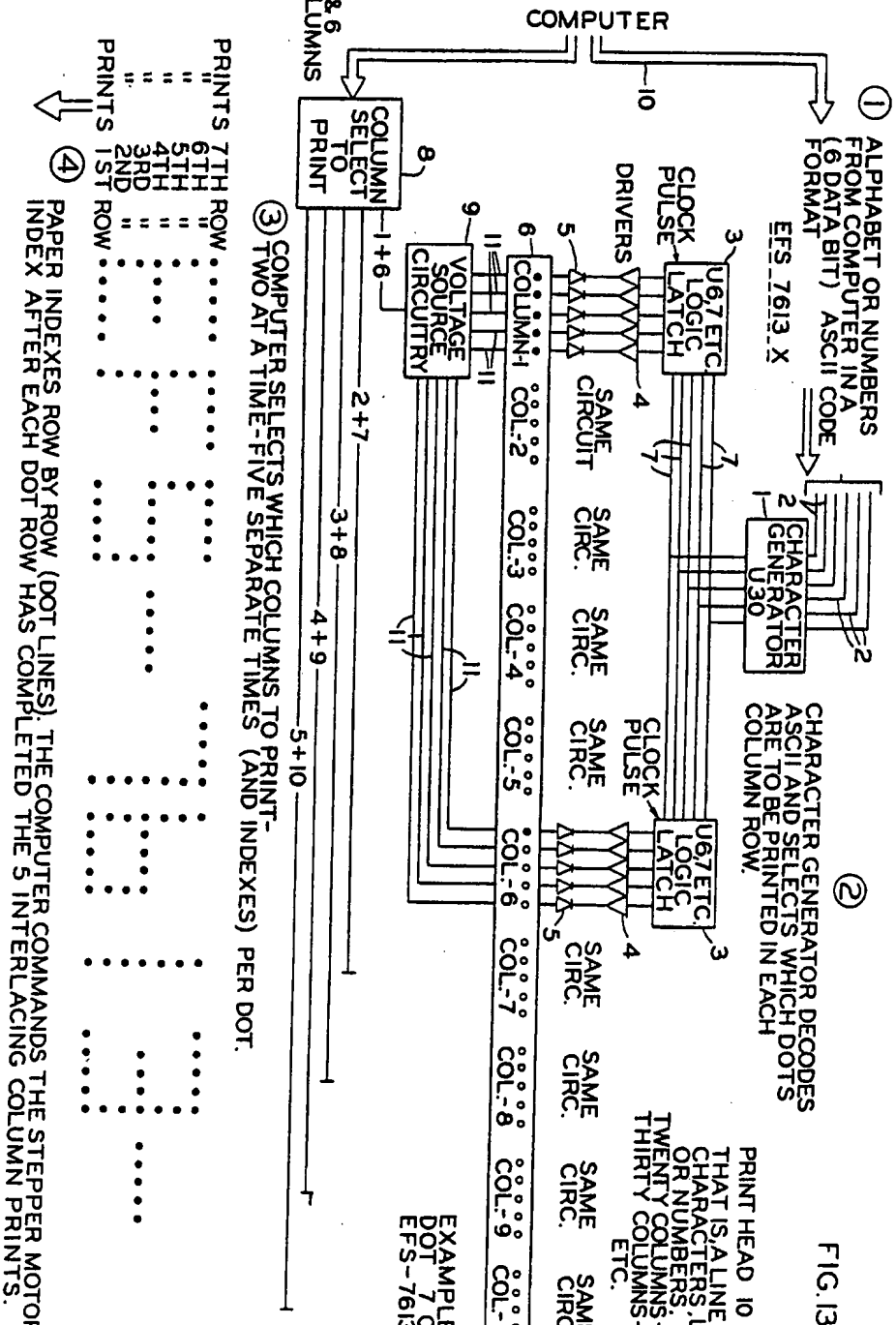

COMPUTER
10
① ALPHABET OR NUMBERS FROM COMPUTER IN A (6 DATA BIT) ASCII CODE FORMAT
EFS 7613 X
CHARACTER GENERATOR U30
② CHARACTER GENERATOR DECODES ASCII AND SELECTS WHICH DOTS ARE TO BE PRINTED IN EACH COLUMN ROW.
U6,7 ETC LOGIC LATCH
CLOCK PULSE
DRIVERS
SAME CIRCUIT
SAME CIRC.
COLUMN-1
COL.-2
COL.-3
COL.-4
COL.-5
COL.-6
COL.-7
COL.-8
COL.-9
COL.-10
VOLTAGE SOURCE CIRCUITRY
COLUMN SELECT TO PRINT
1 & 6 COLUMNS
1+6
2+7
3+8
4+9
5+10
③ COMPUTER SELECTS WHICH COLUMNS TO PRINT-TWO AT A TIME-FIVE SEPARATE TIMES (AND INDEXES) PER DOT.
PRINTS 7TH ROW
6TH
5TH
4TH
3RD
2ND
PRINTS 1ST ROW
④ PAPER INDEXES ROW BY ROW (DOT LINES). THE COMPUTER COMMANDS THE STEPPER MOTOR TO INDEX AFTER EACH DOT ROW HAS COMPLETED THE 5 INTERLACING COLUMN PRINTS.
EXAMPLE SHOWS DOT 7 OF EFS-7613 X
PRINT HEAD 10 COLUMN THAT IS,A LINE OF TEN CHARACTERS.LETTERS OR NUMBERS. TWENTY COLUMNS-2 HEADS THIRTY COLUMNS-3 HEADS ETC.

FIG. 13

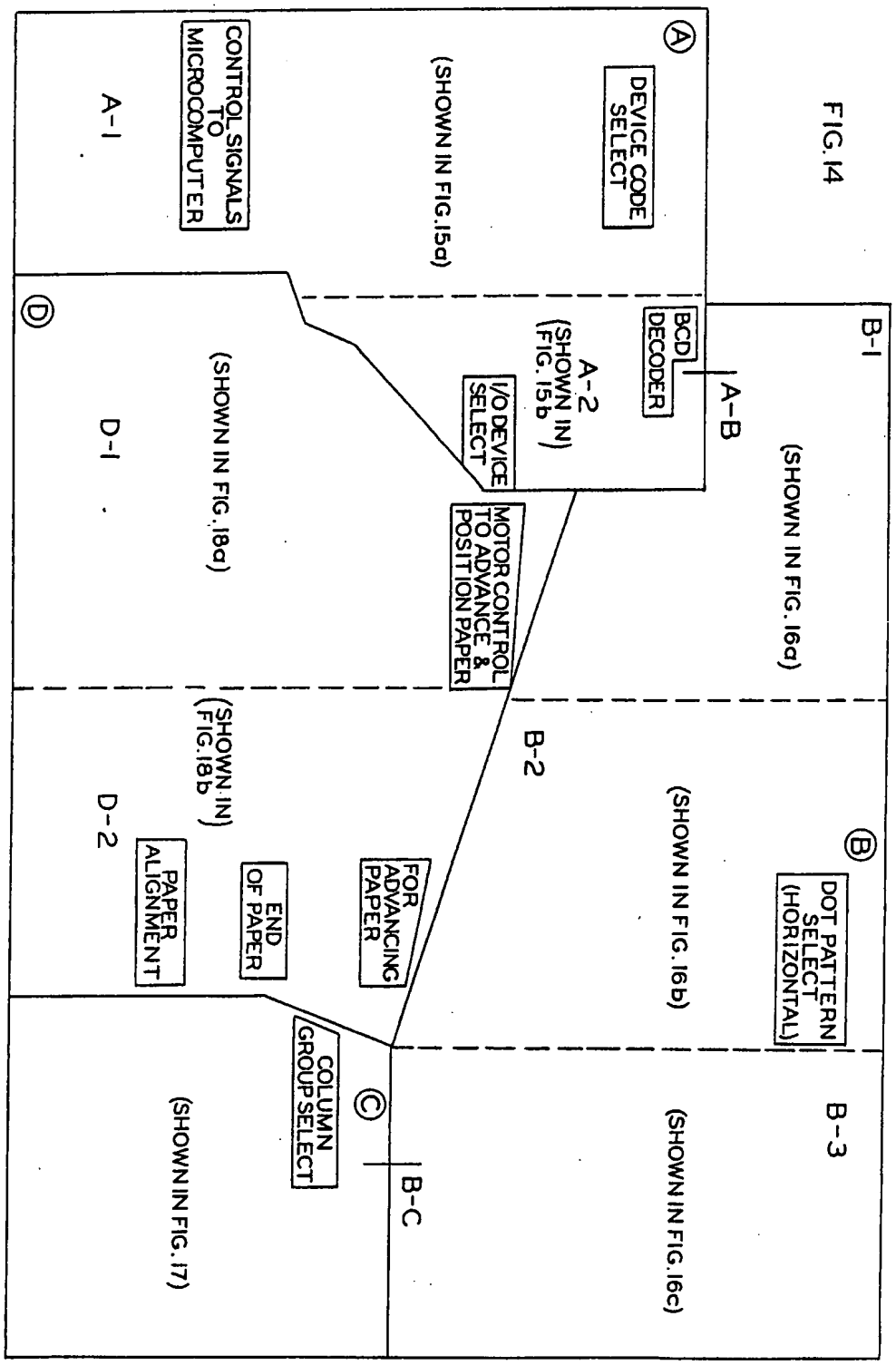

A
DEVICE CODE SELECT
BCD DECODER
A-B
A-2 (SHOWN IN FIG. 15b)
I/O DEVICE SELECT
(SHOWN IN FIG. 15a)
CONTROL SIGNALS TO MICROCOMPUTER
A-1
B-1
(SHOWN IN FIG. 16a)
B
DOT PATTERN SELECT (HORIZONTAL)
(SHOWN IN FIG. 16b)
B-2
B-3
(SHOWN IN FIG. 16c)
D
(SHOWN IN FIG. 18a)
D-1
MOTOR CONTROL TO ADVANCE & POSITION PAPER
(SHOWN IN FIG. 18b)
D-2
PAPER ALIGNMENT
END OF PAPER
FOR ADVANCING PAPER
C
COLUMN GROUP SELECT
B-C
(SHOWN IN FIG. 17)

FIG. 14

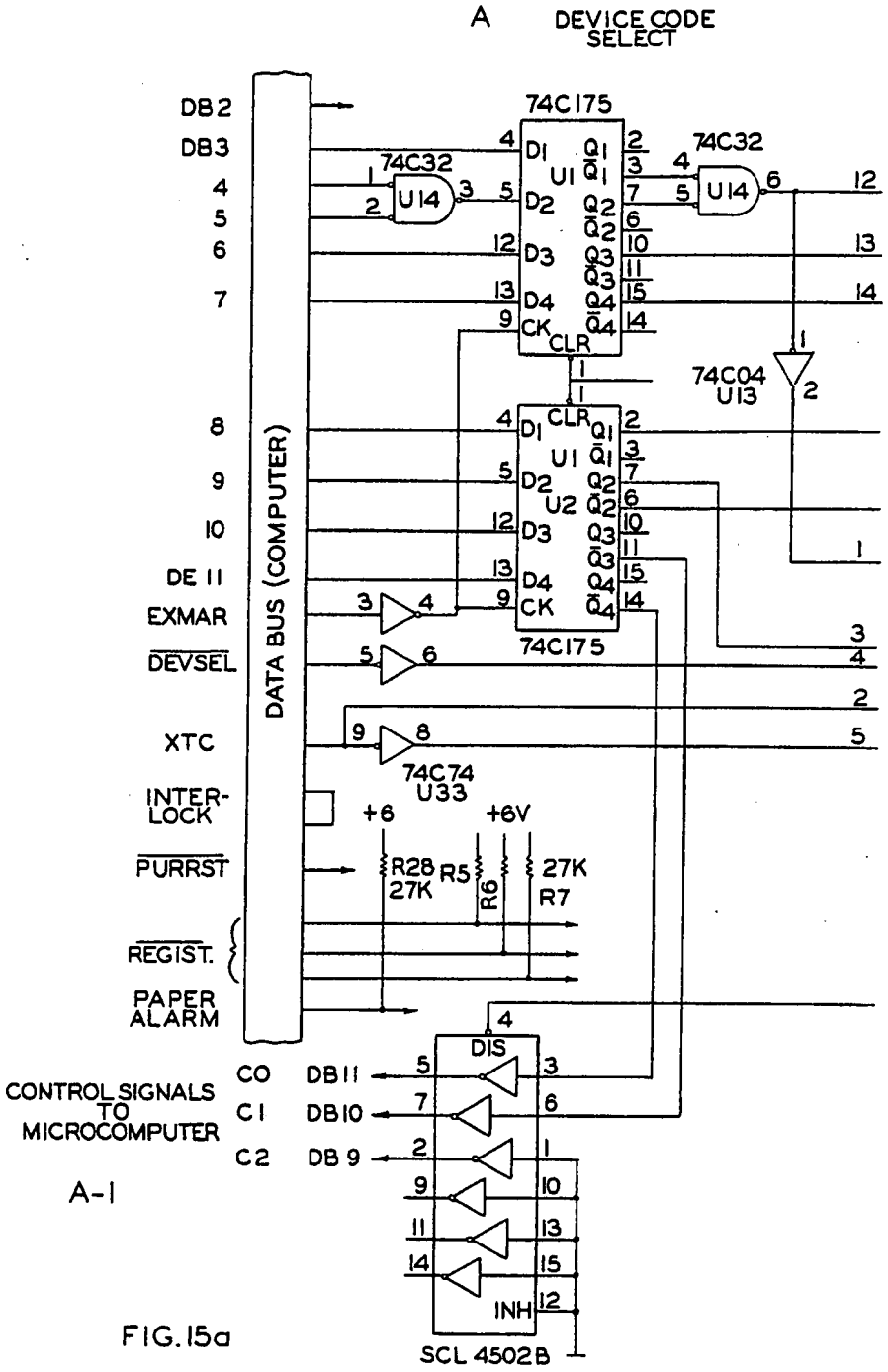

A
DEVICE CODE SELECT
DB2
DB3
4
5
6
7
8
9
10
DE 11
EXMAR
DEVSEL
XTC
INTER-LOCK
PURRST
REGIST.
PAPER ALARM
DATA BUS (COMPUTER)
74C175
U1
U2
74C32
U14
74C04
U13
74C74
U33
74C175
+6
+6V
R28 27K
R5
R6
27K
R7
DIS
INH
SCL 4502B
CONTROL SIGNALS TO MICROCOMPUTER
C0
C1
C2
DB11
DB10
DB 9
A-1

FIG. 15a

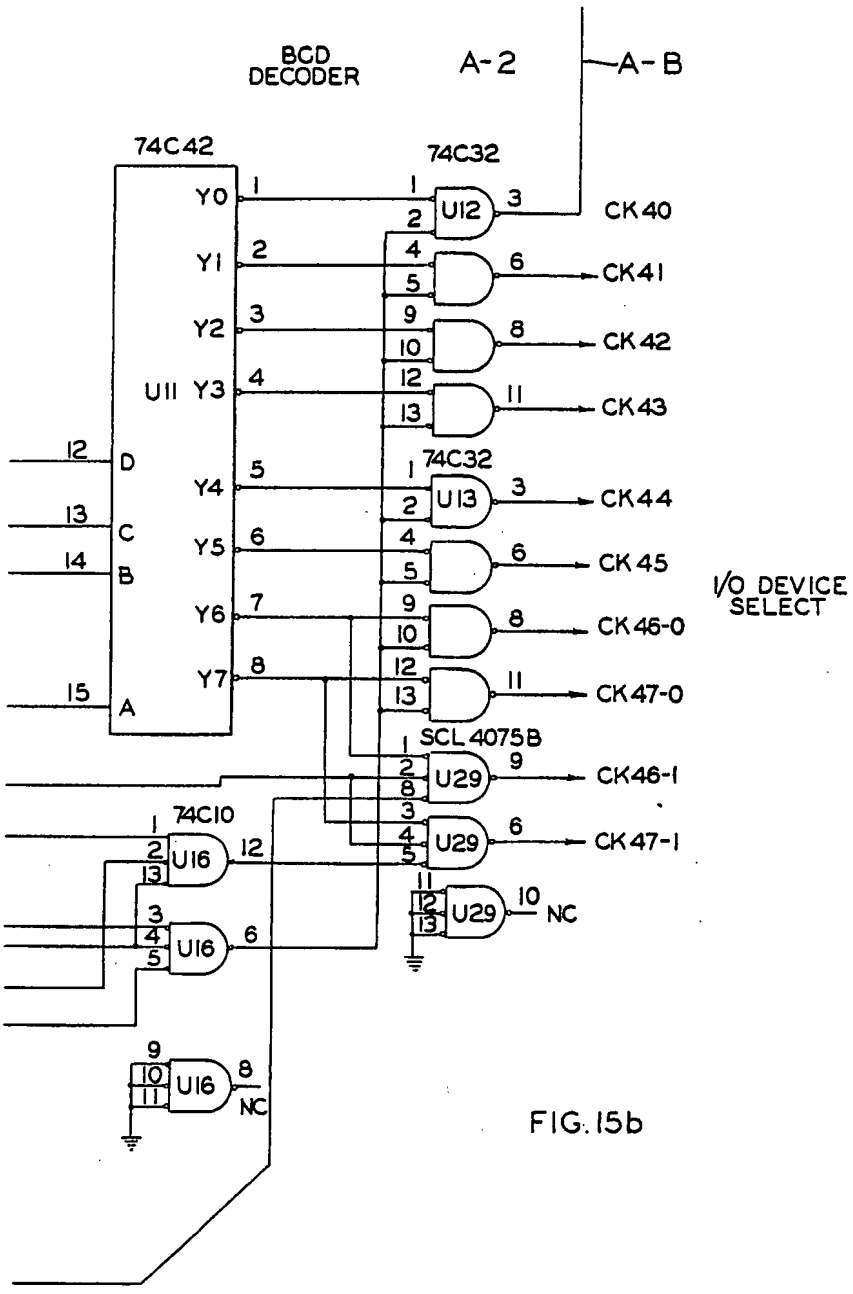

BCD DECODER
A-2
A-B
74C42
U11
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
D
C
B
A
12
13
14
15
74C32
U12
CK40
CK41
CK42
CK43
74C32
U13
CK44
CK45
CK46-0
CK47-0
I/O DEVICE SELECT
SCL 4075B
U29
CK46-1
CK47-1
NC
74C10
U16
NC

FIG. 15b

B-1

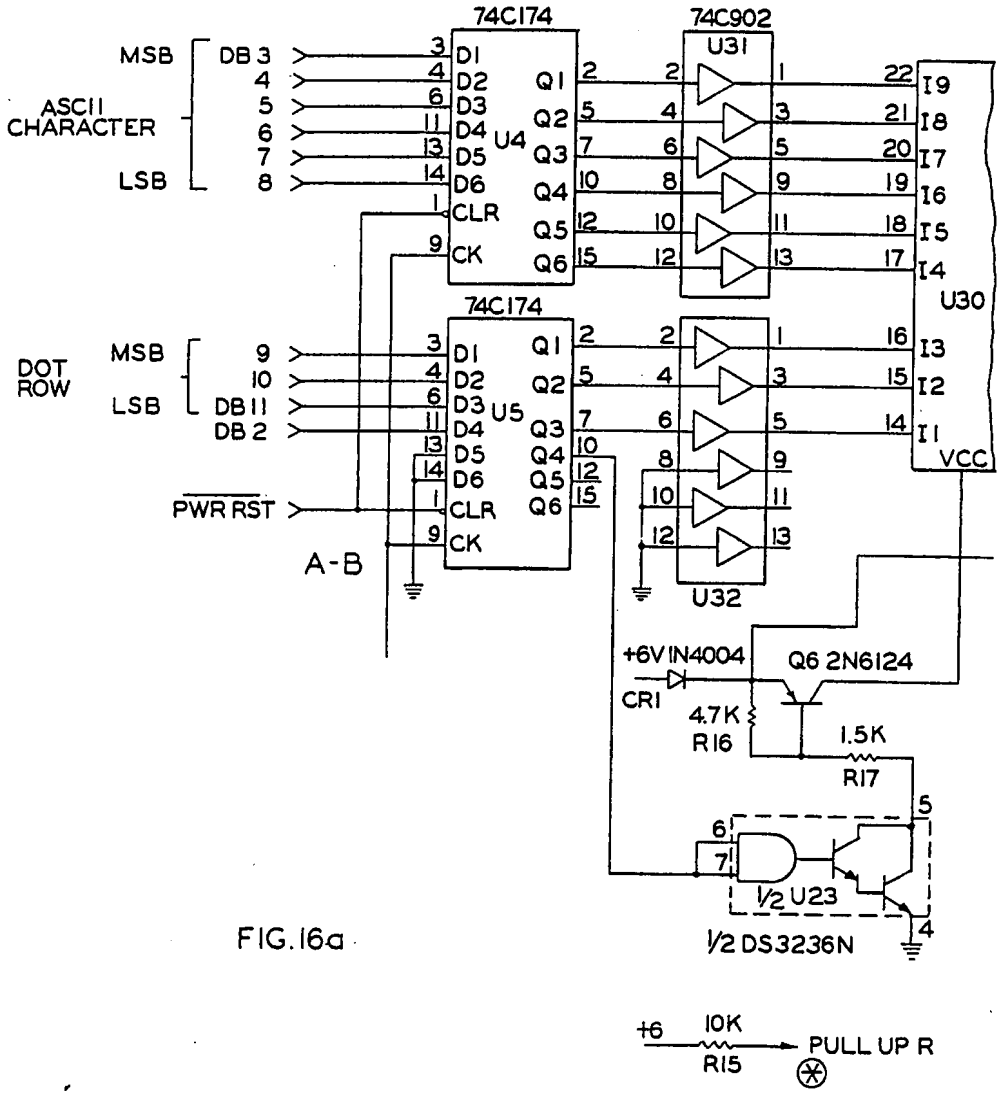

74C174
74C902
U31
MSB
DB 3
4
5
6
7
LSB
8
ASCII CHARACTER
D1
D2
D3
D4
D5
D6
CLR
CK
U4
Q1
Q2
Q3
Q4
Q5
Q6
I9
I8
I7
I6
I5
I4
U30
74C174
DOT ROW
MSB
9
10
LSB
DB 11
DB 2
U5
I3
I2
I1
VCC
PWR RST
A-B
U32
+6V IN4004
CR1
Q6 2N6124
4.7K
R16
1.5K
R17
1/2 U23
1/2 DS3236N
+6
10K
R15
PULL UP R

FIG. 16a

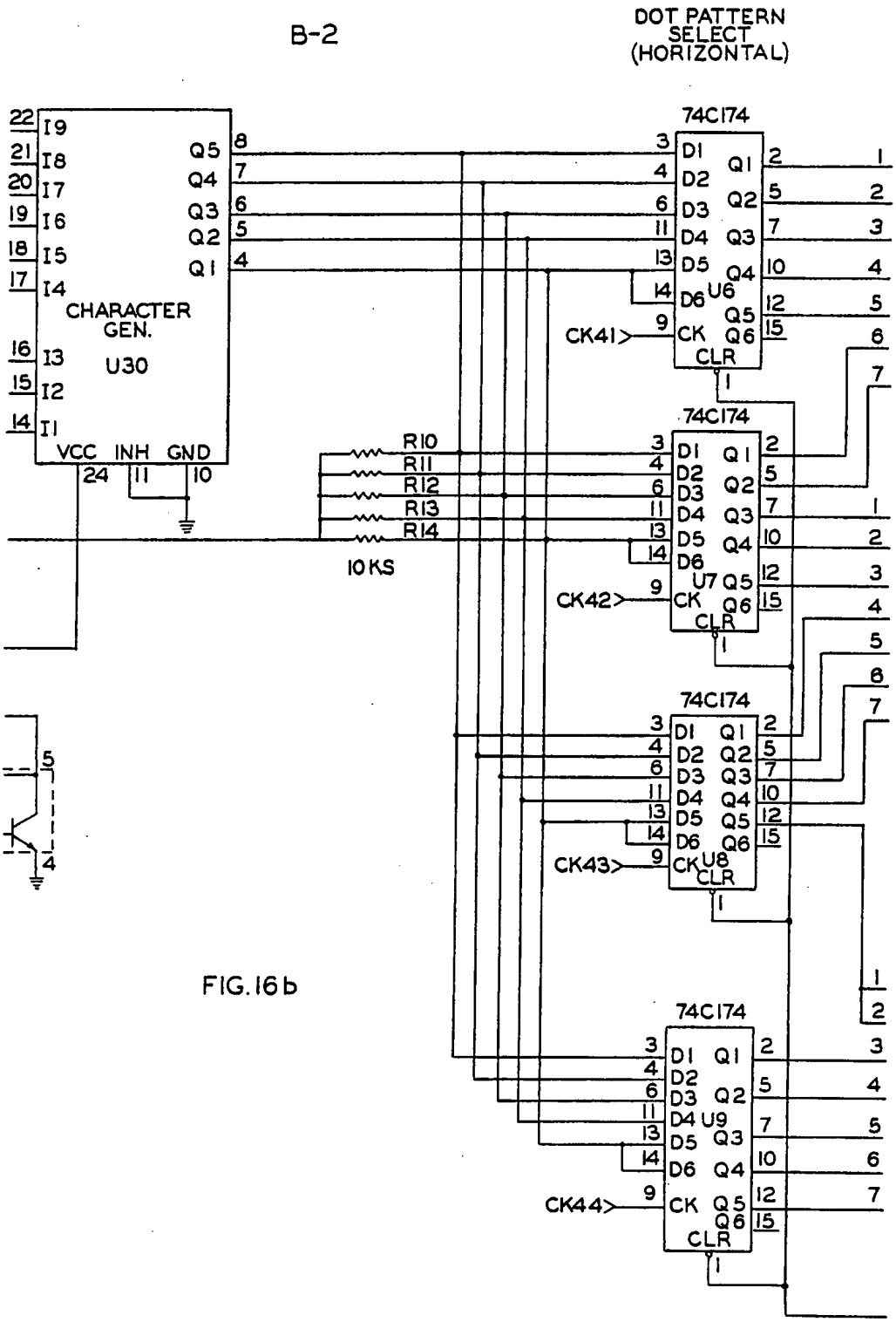

B-2
DOT PATTERN SELECT (HORIZONTAL)
CHARACTER GEN.
U30
VCC INH GND
I9 I8 I7 I6 I5 I4 I3 I2 I1
Q5 Q4 Q3 Q2 Q1
R10 R11 R12 R13 R14
10KS
74C174
U6
U7
U8
U9
D1 D2 D3 D4 D5 D6
Q1 Q2 Q3 Q4 Q5 Q6
CK
CLR
CK41>
CK42>
CK43>
CK44>

FIG. 16b

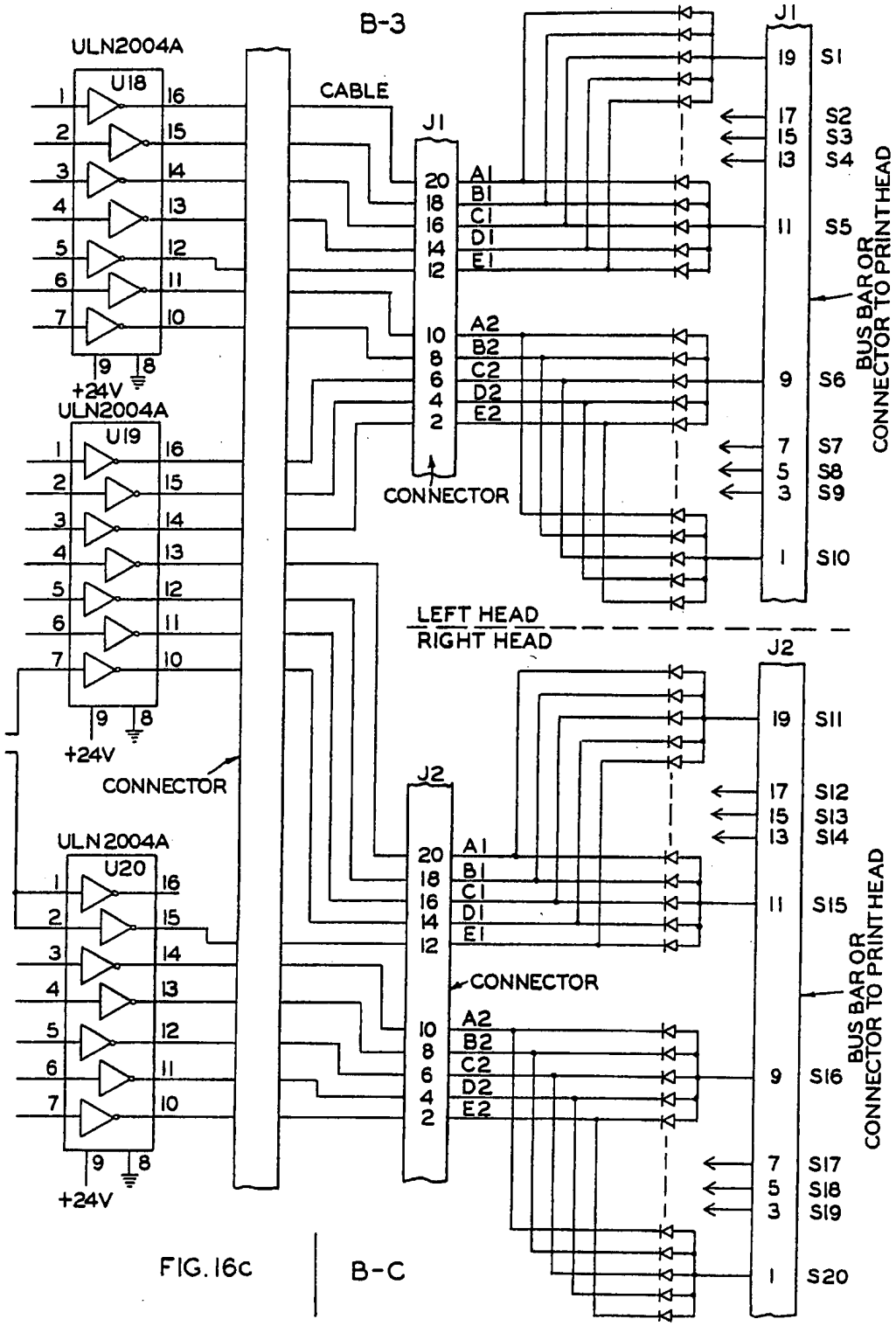
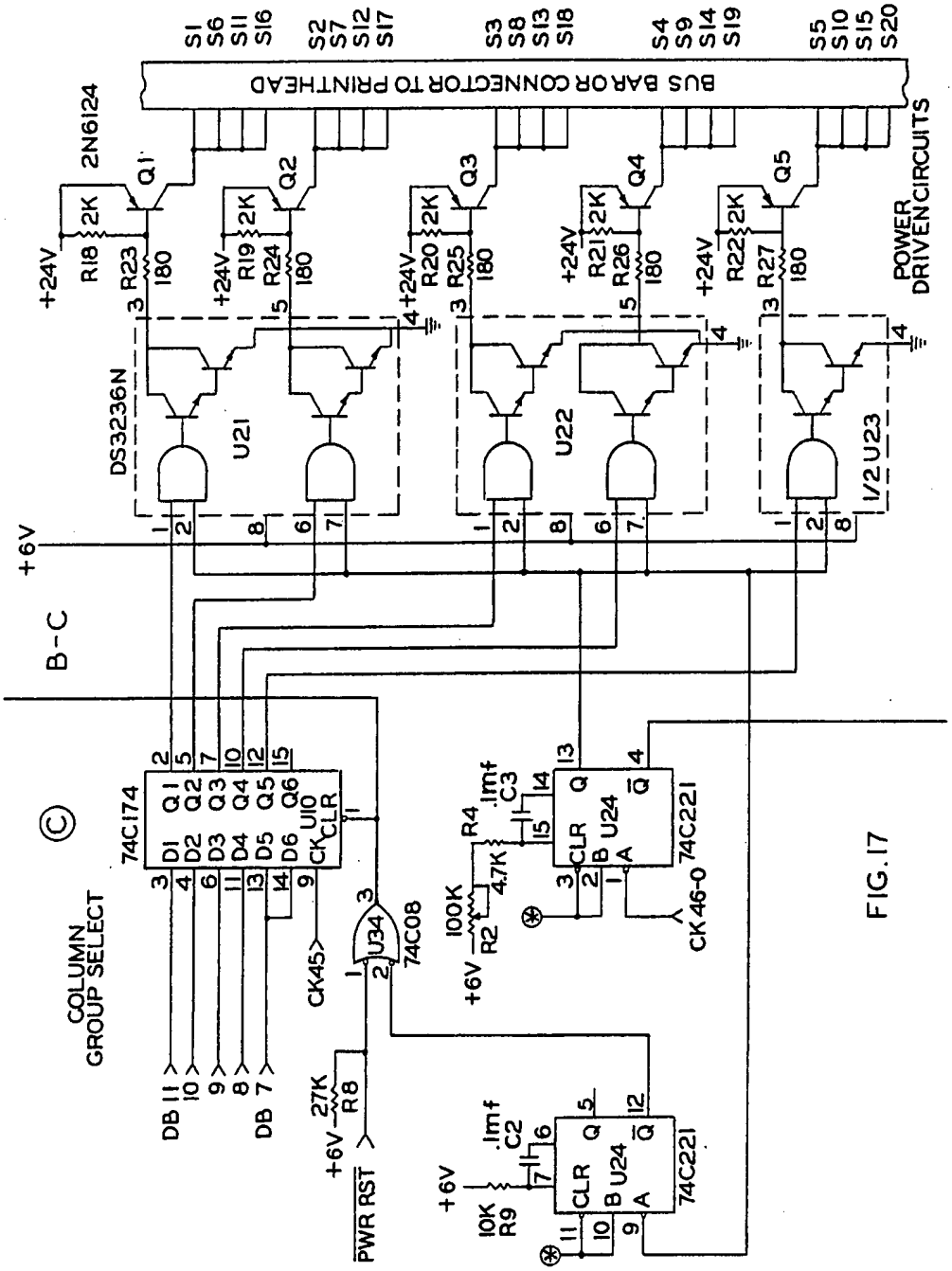
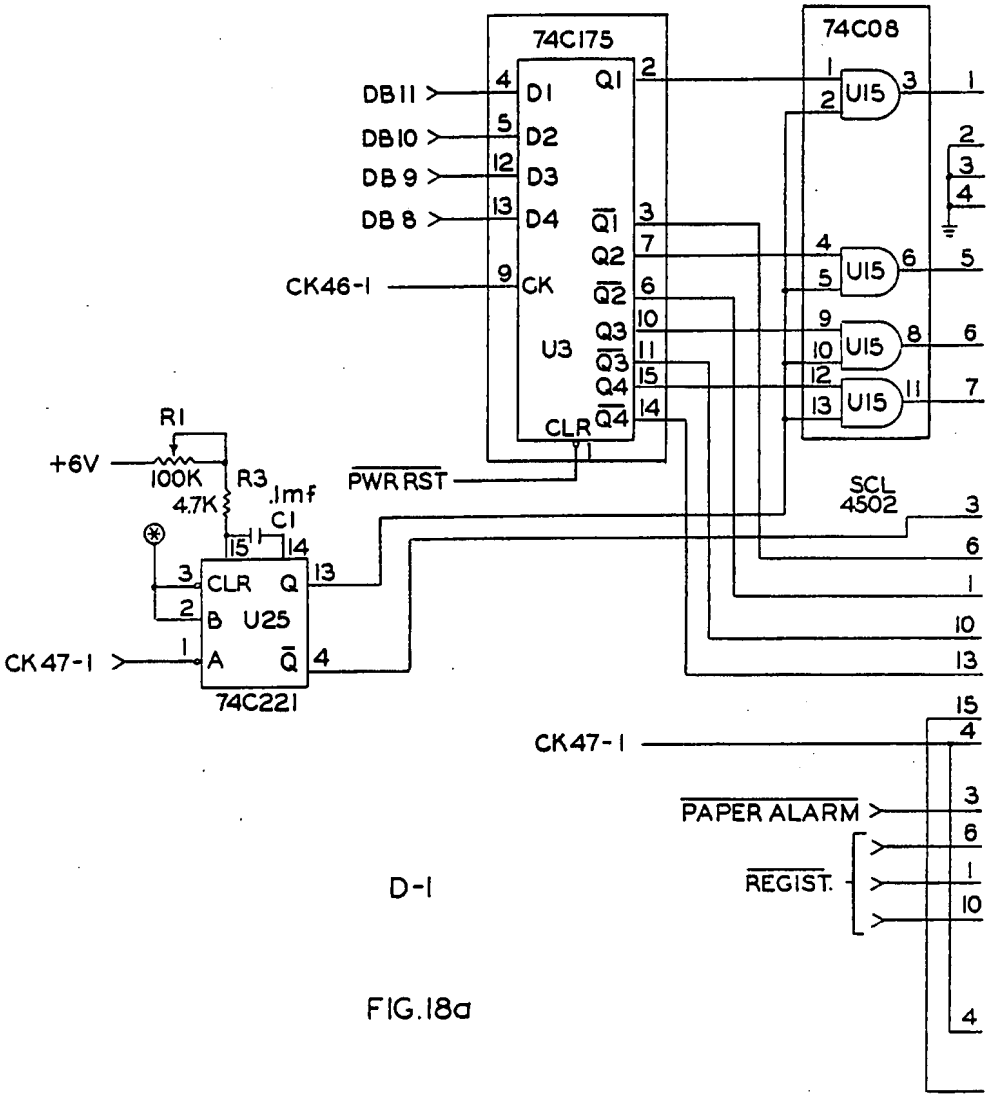

B-3
ULN2004A
U18
U19
U20
CABLE
J1
J2
CONNECTOR
+24V
LEFT HEAD
RIGHT HEAD
BUS BAR OR CONNECTOR TO PRINT HEAD
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
S20
B-C

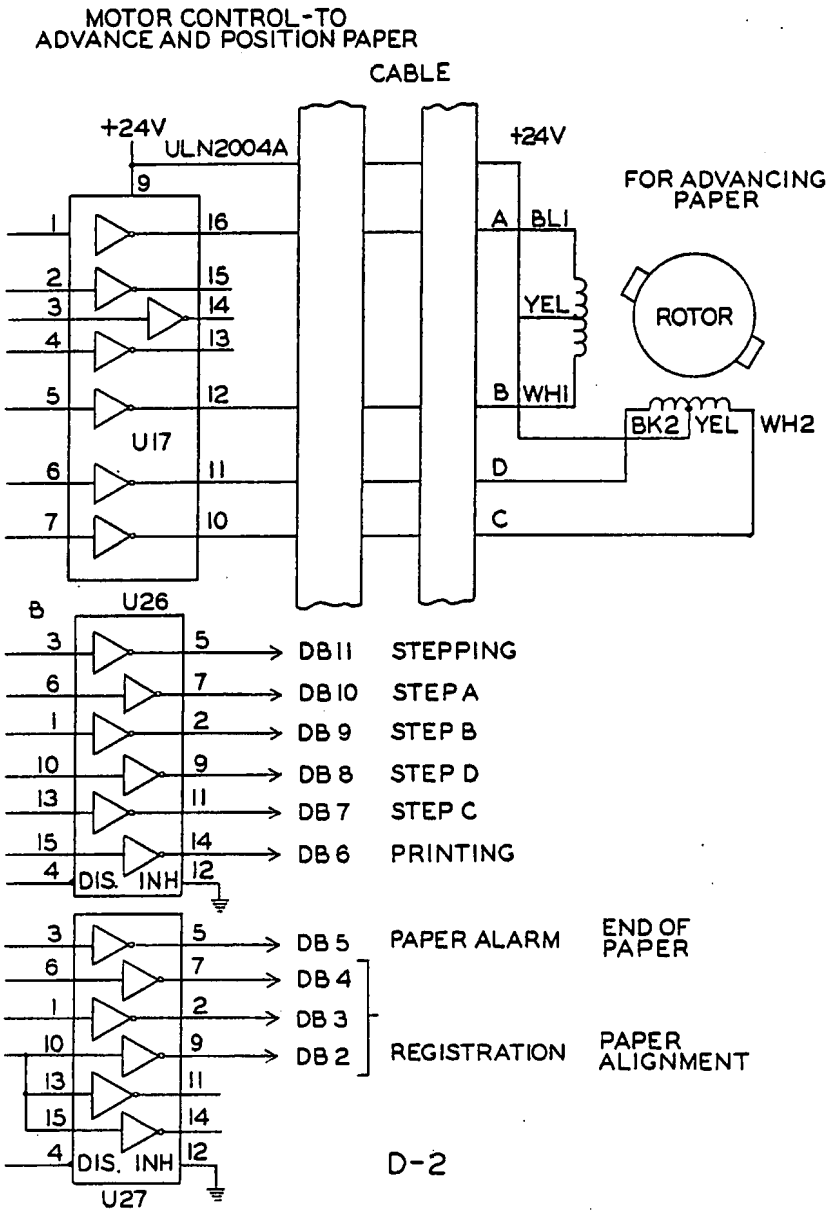
FIG. 16c


BUS BAR OR CONNECTOR TO PRINTHEAD
S1 S6 S11 S16
S2 S7 S12 S17
S3 S8 S13 S18
S4 S9 S14 S19
S5 S10 S15 S20
2N6124
Q1
Q2
Q3
Q4
Q5
+24V
2K
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
180
POWER DRIVEN CIRCUITS
DS3236N
U21
U22
1/2 U23
+6V
B-C
74C174
U10
D1 D2 D3 D4 D5 D6
Q1 Q2 Q3 Q4 Q5 Q6
CLR
CK
74C08
U34
CK45
COLUMN GROUP SELECT
DB 11
10
9
8
DB 7
27K
R8
PWR RST
100K
R2
4.7K
R4
.1mf
C3
74C221
U24
CLR
B
A
CK46-0
10K
R9
C2
FIG. 17


74C175
74C08
DB11
DB10
DB 9
DB 8
CK46-1
D1
D2
D3
D4
CK
Q1
Q2
Q3
Q4
U3
CLR
U15
U15
U15
U15
R1
+6V
100K
4.7K
R3
.1mf
C1
PWR RST
SCL
4502
CLR
B
A
Q
U25
74C221
CK47-1
CK47-1
PAPER ALARM
REGIST.

D-1

FIG.18a


MOTOR CONTROL-TO ADVANCE AND POSITION PAPER
CABLE
+24V
ULN2004A
9
+24V
FOR ADVANCING PAPER
A BL1
YEL
ROTOR
B WH1
BK2 YEL WH2
D
C
1
2
3
4
5
6
7
16
15
14
13
12
11
10
U17
B
U26
DB11 STEPPING
DB10 STEP A
DB 9 STEP B
DB 8 STEP D
DB 7 STEP C
DB 6 PRINTING
DIS. INH
DB 5 PAPER ALARM
END OF PAPER
DB 4
DB 3
DB 2
REGISTRATION
PAPER ALIGNMENT
U27

D-2

FIG. 18b

SPECIFICATION

A Portable Computing-printing Device

Field of the Invention

This invention relates to a portable device capable of regenerating recorded information regarding a utility customer at a specific address, to record new information regarding said customer's use of such utility, computing the charge for such utility service, and on-the-spot printing of a bill to be left on the customer's premises. More specifically it relates to such a device designed to be easily transportable and to be capable of withstanding hostile weather and handling conditions and consume minimal battery power.

State of the Prior Art

According to present practice, electric, gas and water meters are read and recorded by a meter-man traveling on foot from one location to another and then transporting this information to a central office. There the information is rerecorded, the charges are calculated, a bill is typed or printed, and the bill is mailed to the customer. Some of these operations, such as the central office recording and the calculation of the charges, may be performed by a computer. However computers presently used for such purposes are extremely bulky, cumbersome and very heavy. This is because of the extremely complicated circuitry and the number of different devices involved in the operation of stationary computers.

With the goal of performing the above-recited functions in a portable unit, the various elements and circuitry comprised in these recording, computing and printing operations must be completely designed and compacted to fit the size and weight requirements of a portable unit. Moreover, none of these various elements are available commercially in a type and size suitable for a portable device. Furthermore, while such stationary devices are generally operated by alternating current and require heavy current demands available from a central power source, such as that available in homes and offices, batteries must be used to power a portable unit as described herein. This means increased weight and also requires that the power drain to operate the device should be kept low to avoid running down the batteries. This is in contrast to the high power used for operation of the stationary and transportable computers and printing equipment.

Microcomputers available commercially at the time of this invention do not lend themselves to the practice of this invention. For the purpose of this invention, microcomputers need to be redesigned to use as few parts as possible and to eliminate redundant parts and parts non-useful for this specific purpose in order to have the lightweight and small size required for a portable unit. Moreover the printing unit must be adapted to be operable for at least a full day by a lightweight battery which means smaller physical size and low power consumption. At the time of this invention such a microcomputer system and such a printer were not available commercially.

Summary of the Invention

In accordance with the present invention, a portable recording, computing and printing device has been discovered as described herein, which performs the aforesaid functions and has a computer-printer manpack unit capable of being compressed in volume to no more than 1/6 of a cubic foot and a weight of no more than 9 pounds. This device comprises a manpack unit which may be easily strapped to and carried by the operator and a hand-held unit by which the operator may retrieve and record information and compute and print the customer's bill. This eliminates numerous operations in the central office, enables faster delivery of the bill and eliminates the associated costs for preparing and addressing the bill, and the postage charge for mailing the bill.

The manpack unit contains a battery, a customer profile memory storage, a billing transactor memory storage, the computer and the printer. The hand-held device contains a digital readout and a keyboard for entering data and for recalling or requesting recorded information and computation therefrom. The computer also issues non-solicited instructions and commands via the hand-held terminal display.

The portable retrieving, recording, computing and printing device of this invention is capable of performing the following functions:

1. To provide a timely bill which reflects the latest and most current billing information, thereby affording the subscriber or customer the opportunity to verify the accuracy of the bill based on the meter reading at the time of billing or shortly thereafter.

2. To print a bill or invoice based on a printing format which is flexible and can be tailored to the end-user's requirements. These variables concern spacing, numerics and/or alpha-numerics, boldness and other specific highlights that may be required for an end-user.

3. To retain a record of when the billing transaction occurred (time of day) for company use and to determine when the company agent was on the customer's premises.

4. To provide an entry of time-of-day on the bill to identify accurately when the billing transaction occurred.

5. To provide the operator with an orderly sequence of locations (routing) which he is to follow and what functions should be carried out at each of these locations, such as reading the electric meter, reading the gas meter, reading the water meter, or any combination of the above, or doing inventory and invoicing functions.

6. To advise the system operator of special procedures or instructions, such as name of person to be contacted, where to obtain further information, location of meter, whether or not to leave the bill or invoice on the premises.

7. To provide the operator with information and other special instructions pertaining to the residence owner such as: should a special effort be made to collect on the bill as a result of prior customer payment history.

8. To alert the system operator of local hazards known to the company, such as whether or not there is a dog on the premises, physical obstacles and routing instructions to avoid these hazards.

9. To allow an authorization procedure such as an access combination to be entered via keyboard to prevent unauthorized operation of the system.

10. To possess the capability of printing in an overlay fashion onto preprinted paper stock or on plain paper.

11. To contain enough contrast and font characters to allow the printed bill to be read by optical character recognition equipment.

12. To use operating computer language which results in the system being operationally compatible with existing computer equipment typical in today's industry and possibly stationed in a central office.

13. To be designed to use a minimum of battery power, thereby reducing the overall weight of the system and increasing the operational period that the system can operate without recharging the battery packs.

14. To be so packaged as to allow reasonable abuse via shock, vibration, humidity, and other hostile environmental conditions as would be expected in outdoor, manpack use.

15. To provide a printing and operating mechanism which minimizes current requirements thereby reducing battery drain and allowing printing to occur on all axes of physical position.

16. To be capable of retrieving from and recording on a magnetic tape medium over a broad temperature range of −25°F to +125°F.

The portable device of this invention comprises:

1. A Hand-Held Unit, and

2. A Manpack Unit or a Computer-Recording-Retrieving-Printing Unit comprising the following elements:

(a) Microprocessor and Associated Logic Circuitry

(b) Memory Interface

(c) Programmable Read-Only Memory (PROM)

(d) Random Access Memory (RAM)

(e) Read-Only Memory (ROM)

(f) Cassette Interface

(g) Printer Interface (I/O) and Control Logic

(h) Hand Terminal Interface (I/O) and Control Logic

(i) Bidirectional Computer Data Bus

Description of these respective units and elements may be facilitated by reference to the drawings in which:

Fig. 1 shows a top view of a typical, hand-held unit with various functional keys:

Fig. 2 is a front elevational view of a typical manpack unit of this invention;

Fig. 3 is a side elevational view of the manpack of Fig. 2 with the side panel removed or cut away;

Figs. 4 and 5 are side and top views respectively of printed circuit board assemblies in the microcomputer;

Fig. 6 represents a typical schematic arrangement of the various elements of the manpack unit;

Fig. 7 represents another schematic layout of various elements in the manpack unit;

Fig. 8 represents a block diagram of the circuit layout of a typical hand-held unit;

Fig. 9 shows another schematic arrangement of a typical hand-held unit.

Fig. 10 is a typical block diagram using specific display modules;

Fig. 11 is another typical block diagram using other specific display modules;

Fig. 12 illustrates the dot pattern sequence used in one modification of printing (shown as an example only);

Fig. 13 illustrates the circuitry used in activating a thermal printhead to print the dots described in Fig. 12;

Fig. 14 is a diagram showing the overall layout of circuits shown in Figs. 15a—18b for controlling and operating type of printer;

Figs. 15a and 15b show the circuitry for device code selection, BCD decoding, I/O device selection and for controlling signals to and from the microcomputer;

Figs. 16a, 16b and 16c show the circuitry for horizontal dot pattern selection;

Fig. 17 shows the circuitry for column group dot selection; and

Figs. 18a and 18b show one type of circuitry for the motor control to advance and position paper for printing.

In using the portable computer-printer of this invention, the appropriate cassette or tape transport is selected for the route being traveled by the operator and inserted in the manpack. This input tape has recorded information pertaining to the various customers whose premises will be visited by the operator. As the operator reaches each customer's house, he punches the appropriate keys on the hand-held unit for that customer. If, for some reason, the operator does not follow the route exactly as designed he can search for any point or customer within the route by engaging a forward search mode of the computer controlled tape cassette. The unit performs a search until the correct customer data file is located at which point the desired file is displayed in the hand-held terminal display and the operator may then continue his route.

The manpack also contains a second (#2) magnetic tape cassette unit which is for recording the transaction information. The computer stores (writes) the new data onto tape #2 including, but not limited to, such data as time-of-day, customer data, new reading, new usage, billing data, plus any special information entered by the operator via the hand-held terminal.

Once the operator has called up the desired customer file, he can enter new information by

depressing different keys for different types of recorded information pertaining to that customer. Also when he reads the meter, he can punch the appropriate keys to record this reading and have the amount of service used since the last reading computed as the difference between the present reading and the last recorded reading, from which the charge is computed by applying the appropriate rate. This information is put on the output (record) tape and then backspaced so that the information can be read on the display unit. Then upon approval by the operator, he can punch the appropriate key or keys to have this information printed on the appropriate form or paper provided in the manpack. The printed form is then left on the premises as the customer's bill.

Hand Terminal

In Fig. 1 the keys for various numerals are as indicated. The keys indicated by the various letters are for particular functions. Panel K is a screen or viewer on which is shown requested information or special instructions such as Battery Low, Paper Low, Tape One Low, Tape Two Low, Re-enter Number, etc. Typical functions performed by pressing the various lettered keys may be: A—ready or initialize; B—print; C—read; D—irregularities such as seal broken, glass broken or routed wrong; E—special; F—special; G—verify; H—estimate—enter code (EST/CK) such as reporting as to dog, obstruction, fence, location of key, etc.; I—name and address; J—advance, etc. The hand terminal is connected by cable to the manpack computer for operation of the various retrieving, recording, computing and printing functions of that unit. If desired the cable may be eliminated by having the hand-held unit operable by radio frequency so that pressing a particular key on the hand-held unit would, by radio wave, activate a corresponding key or activate the desired function in the manpack.

Manpack Computer

The physical arrangement of a typical manpack unit is illustrated in Figs. 2—5. Figs. 2 and 3 show the magnetic tape transports 21 and 22 advantageously positioned at the front and top of the unit. The means for support and easy replacement are not shown. The battery pack 23 is preferably located at the top rear. The microcomputer 24, comprising various printed circuit boards 25 together with printed circuit boards for operating the other electronic elements and for operating the printer occupies the middle portion. The printing unit 28 and paper dispenser 29 are at the bottom of the manpack unit with orifice 26 in the front cover provided for emission of the printed bill. This orifice is protected by shield 27.

The paper dispensed to the printer may be either in roll form as shown, or lying flat as with fan-fold paper, or by using standard data processing type cards. The paper is perforated across the width of the paper at appropriate lengths and has grooves or notches cut in one or both lateral edges at the ends of each alternate line of perforations. The notches aid in the registration of the paper in the printing operation and facilitate in severing each individual bill as it is emitted through the orifice. The intermediate unnotched lines of perforations permit the customer to divide the bill into two sections, one for returning with payment and the other to be retained as his record.

Paper roll 30 is supported on roller 31 (supporting means for roller not shown). Spring bar 32 is fastened to back wall 33 of the unit and exerts a drag on the revolution of roll 30 so as to provide tension in the paper 34 being fed over rod 35. Since paper coming from a roll generally has a curve in it, this tension over rod 35 acts to remove this tendency for the paper to curl or curve. This drag bar system is a unique method for removing this curling or curving tendency of rolled paper. The paper is pulled over rod 35 by the rotation of roll 36 which is driven by a motor (not shown) on the opposite side of roll 36. Tension bar 37 presses the paper against roll 36 so that the resulting friction between the paper and the roll advances the paper. As explained in more detail below, the roll 36 advances the paper one lateral printing space at a time so that the paper is at rest when the appropriate information is being printed one lateral line at a time.

Roll 36 is supported and rotated by shaft 38 and tension bar 39 presses against shaft 38 to prevent movement between the incremental revolutionary movements described above. The printing unit is supported by bars 39 fastened by bolts 40 to front wall 28. Extension 42 of tension bar 37 also presses against the paper 34 before it comes into contact with roll 39.

Figs. 4 and 5 are a side view and a top view, respectively, of the printed circuit boards which constitute the computer and the various electronic mechanisms for the retrieving, recording, computing and printing operations of this invention. The printed circuit boards 25 are assembled and supported by fitting the ends thereof into slots 41 and 41', respectively, in horizontal boards 42 and 42' affixed to sidewalls 43 and 43'. Crossbars 44 are fastened to sidewalls 43 and 43'. Outer shield 45 covers the assembly.

The manpack unit is a compact microprocessor based system with integral power pack that is specifically designed for portable applications. Correspondingly, all components are specified to minimize power drain.

A block diagram of a typical microcomputer of this invention is shown in Fig. 6. In this particular unit all components are serviced by a bidirectional data bus consisting of six control and twelve data lines.

The microcomputer provides all control and timing signals for the system.

The memory interface provides the field address decoding and memory select logic for the Read Only Memory (ROM), the Programmable Read Only Memory (PROM) and Random Access

Memory (RAM) sections of memory. The memory interface logic allows program and data flow between the various memory fields in an orderly fashion, maintaining field pointers within the computer registers.

The EPROM and ROM are permanent instruction/data set memories which contain the basic I/O routines required for data transfer between each device and the microprocessor. Also included within these devices is a program loader with which to load the operational program into the portable manpack unit. The loader program begins executing upon power-up or system reset.

The RAM is also used for both instruction and data. However, these are volatile and the data stored can be readily and dynamically modified. In addition to specific user instruction/data, the RAM also serves as temporary storage for customer data, scratch-pad, systems stack, address pointers and buffer areas.

Bulk memory storage is necessitated for autonomous field operation. This serves as both a portable data base as well as a record of transactions. Various practical methods for portable bulk storage may be used such as cassette, tape, solid state devices (CCD's) and magnetic bubble memory. This typical application uses cassette tape media.

The cassette interface logic provides command and data latching for output enable and status and data for input to the processor for both digital cassettes. Command outputs provide tape motion and head read/write selection. Tape motion options are Stop/Go, Fast/Slow, Reverse/Forward. Status inputs are write protect, tape present, side A/B and clear tape leader. A single data bit is provided for data input and data output. Data is phase encoded by the software in the tape I/O routines. However, this may be accomplished via hardware. Device codes are used to select tape drive, command, status or data and input/output (I/O).

The power pack consists of rechargeable batteries, power distribution and charge condition indicators.

The software for the manpack unit may be contained in PROM and RAM and on tape. The software in PROM consists of the device I/O drivers and loader program necessary to bring the operational program into memory from cassette tape. The I/O device routines are structured such that once the operational program is loaded into memory, the device routines may be used by the operational program. Also stored in PROM are frequently used tables of data.

As shown in Fig. 7, the operationl program resides in several fields of the RAM, but could be in PROM or ROM. The program consists of three major areas—the control program, the billing algorithm, and the output formatter. The control program leads the operator through the necessary steps to enter the information required for the billing algorithm, with verification procedures for out-of-norm or unusual inputs. Once all inputs are entered, the billing algorithm is invoked to compute all the items to be included in the bill such as surcharges, debits or credits, taxes and subtotals. When the bill computation is complete, all information is transferred to the output cassette tape. The output cassette tape is backspaced over this data and re-read to insure accurate recording. This read after write could be done via hardware. If no errors are encountered, the bill formatter program is invoked to format the billing information assembled and generated by the billing algorithm. The bill is then printed on operator command. The bill or invoice may contain any number of additional alpha-numeric data such as names, addresses and special information, in addition to the invoice mathematics.

Hand Terminal

The hand terminal provides the user a means for entering data into the central processor and retrieving data from it. Fig. 8 illustrates the block diagram for this terminal.

The interface with the typical central processor will generally be two serial data streams. This interface could be implemented using parallel data although this would require more wires, thereby making the interconnecting cable more bulky.

Inside the hand terminal the data are more easily generated and used in parallel form. To make the conversion from serial to parallel and vice versa, an integrated circuit called a Universal Asynchronous Receiver Transmitter (UART) may be used.

Serial data received from the central processor is then converted to parallel data words and transferred into the display drive circuits. These circuits decode the data and set up the proper voltages to the display elements to display the appropriate characters.

When the user depresses a key on the key pad for data entry, the key pad encoder generates a parallel data word. This data word is converted to serial data by the UART and transmitted to the central processor.

Key Pad

In physical arrangement, the keys in the hand-held unit may have various configurations depending on user requirements but generally these conform to standard human engineering practices as typified by the block diagram of Fig. 9. In this case the letter F represents various function keys.

Standard encoding devices are available for detecting that a key has been depressed and then generating a unique code for that key. The key pad encoder constantly scans the X and Y lines of the key pad, testing each combination for a switch closure. When a closure is found, a code is generated corresponding to the X and Y coordinates of that key, and the code is sent to the UART for transmission to the CPU.

Display

There are a number of techniques available for implementing the displays and their drive circuits. Figs. 10 and 11 illustrate two alternative configurations. These both use light emitting diodes (LED's) but could be liquid crystal displays (LCD), or gas discharge or vacuum fluorescent displays.

The basic display element used in Fig. 10 may be the Litronix DL-1416 module, available commercially. This module contains four alphanumeric LED displays, and the necessary storage and decoding circuitry for driving the display elements.

To display a character in one of the twenty positions shown, the central processor transmits two data words to the terminal. The first data word specifies the character position and is stored temporarily in the storage buffer. This data is then decoded to generate an enable line for the particular character position specified. The second data word specifies the character to be displayed and is routed to all the display modules. However, the data is only accepted and stored by the display module that has been previously enabled.

Fig. 11 illustrates a 20 digit or 20 character display using the HP HDSP-2000 module as the display element. This module may also use a four character LED unit, but its storage and drive circuits are considerably different from the Litronix unit. It contains a shift register to hold the data bits for one row of each character. Each digit display comprises a rectangular column made up of five vertical rows of dots, with seven dots in each vertical row. Only one horizontal row of each character or column can be illuminated at any time, necessitating that the display be rapidly scanned and refreshed to avoid flickering.

Data from the central processor is stored in a 6×20 random access memory in specific locations corresponding to the 20 character positions. This memory data will be continually read out by the counter for transfer to the display. As a character is read out of the memory, it is decoded by a character generator into the 5×7 dot pattern required to form that character. At the same time, a row counter is being advanced to select one of the five rows of bits from the character generator. The seven bits in that row are then shifted serially into a display module and used to briefly illuminate that row of character dots. This process is continued to illuminate all the character positions, at a rate fast enough to prevent flicker.

Printer

Portable printing is provided by this system. Thermal, impact and electrostatic printer techniques are practical for the present invention. This particular modification uses a thermal printer.

The printer interface contains the necessary controls to generate and print a line of dot patterns and advance the printer paper by a distance of one dot spacing. Status information is input to the processor for stepper motor position and print cycle timing. A ROM is provided so that a 6-bit ASCII coded character combined with a dot-row-identifier is converted to a 5-bit pattern latched into a particular column position for the print head. An output command enables the print strobe signal for the pattern to form the dot-row for that line. The paper is advanced by energizing the stepper motor windings according to the stepper command output from the processor. A status data bit indicates when the stepping procedure is complete. Another status bit provides for paper registration status.

Printheads are available commercially, but for the purpose of this invention, special circuitry is required for their operation. The printhead is flat and may have ten rectangles of dots arranged with five dots in each horizontal line in each rectangle and seven dots in each vertical line in each rectangle or may consist of a single row of dots. Multiple printheads may be combined end to end to give a number of rectangles of dots and/or to extend a row of dots to the desired length. Resistors are located at each dot so that when the computer or logic control selects a particular letter or numeral to be printed, current is supplied to the appropriate dots. The heated dots in contact with the paper heat the specially treated paper to 90°C which releases a coloring agent in the specific heated areas. In other words, the computer selects the dot row and dot line in which dots are to be heated and power for heating is supplied only to selected dots. For the purpose of this invention, printheads are preferred having a single horizontal row of dots with series of five dots closely spaced an each such series spaced from each other so that after seven advancements of the paper there will be columns of dots five dots wide and seven dots vertically.

The paper is advanced one dot row at a time and the heating of the dots is effected only when the paper is at rest between these dot row advancements. When the dot row advancements have progressed through the seven vertical rows of dots, the complete letter or numeral is printed. The print current is supplied in pulse form and only when the paper is at rest.

Fig. 12 shows two examples illustrating the manner of printing letters and numerals using one modification of a printer of this invention. This system uses a print head of ten columns or characters. For 20 or 30 columns or characters, two or three of these print heads may be used end to end. However, special circuitry is required for the operation of these print heads as described below. As indicated above, the paper is advanced stepwise through the printer with a pause in between steps so that the printing is effected while the paper is at rest.

As indicated in Example I, the appropriate dots may be heated in two columns at a time, first the appropriate dots in columns 1 and 6, then in columns 2 and 7, 3 and 8, 4 and 9 and finally, in columns 5 and 10. This two column sequence is effected so that there is not a high drop or drain

on the battery as would occur if all 7 columns were used for printing simultaneously. If sufficient power is available, as in a stationary machine, the 7 columns or even more could be heated or "burned" at once, but with a limited power supply as in a battery, it is preferred to proceed stepwise. Once the five sequences of two columns at a time have been printed in the first line of dots, the paper is advanced one line so that the second line of dots may be printed.

The first line of dots printed is the bottom line of dots in the lowest line of the legend which is to be printed on the ultimate product. As explained elsewhere, the entire message has been punched on the keys, stored in the memory bank, transmitted to the computer and the computer transmits to the printer the sequence of printing steps or dots to be "burned" in each row to form the letters and numerals comprising the entire message. While the expression "burned" is used in the art, the paper is not "burned" but instead merely heated to 90°C to release a dye from the treated paper.

Once the paper has been advanced for printing of the second row of dots, the same sequence is used as for line 1, namely columns 1 and 6, then 2 and 7, then 3 and 8, etc. until that line of appropriate dots is formed. Then the paper is advanced another line so that the third line of dots can be printed, etc. As shown in Example 2, the letters or numerals appear progressively from the bottom upward as each line is printed. In this case the print of EFS-1613-X is completed upon "burning" of the 7th line.

If for any reason it is desired to have the first line of a message printed first, this may be done by making appropriate changes in the sequence of dot burnings and have the first line of the message printed first with the letter or numeral dots burned in reverse or "upside down" as compared to the procedure described above.

The burning sequences are advanced so rapidly through the five horizontal sequences in each line and through the seven vertical advancements, that a line of numerals and/or letters is effected within 3 or 4 seconds.

Instead of the 7 vertical dot arrangement described above, there may be more or less dots in the vertical arrangement. For example with a 9 dot vertical arrangement more distinct lettering is permitted. While the above column arrangement can be made in the resistors in the printhead which print or burn the dots, in which case the line or lines of resistors would be selected in accordance with the number of columns and lines which would be printed simultaneously or progressively, it is also possible and preferable to have a single horizontal line of resistors in the printhead and to obtain the column effect by advancing the paper across this single line of resistors one row at a time. As indicated elsewhere, the number of columns in which the dots are printed simultaneously is restricted, preferably to one out of five columns so that there is less simultaneous or peak power drain on the battery.

Fig. 13 shows the circuitry for operating the print head. The character generator 1 receives information from the computer 10 through lines 2, in a 6 data bit ASC II code format, decodes this information and selects which dots are to be printed in each column row. The drawing shows a logic latch 3 and drivers 4 and 5 connected for columns 1 and 6 in print head 6. In stepwise fashion, similar logic latches and drivers are activated for columns 2 and 7, 3 and 8, 4 and 9 and 5 and 10, respectively. As information is received from character generator 1 as to which dots are to be printed in columns 1 and 6, this is passed through lines 7 to the logic latches 3 and drivers 4 and 5 for columns 1 and 6 and then a pulse of current is applied to the appropriate dots in columns 1 and 6. Then appropriate messages are sent to the appropriate dots in columns 2 and 7 for dot burnings there if indicated, etc. After the appropriate dots have been printed in columns 5 and 10, the rotor (not shown) is activated to advance the paper (not shown) one dot line, and the procedure is repeated with appropriate dots being printed in that line. In each case the computer 10 selects the column and dots to be printed, transmits this information to the column select 8 and activates the voltage source circuitry 9 and sends a pulse of current through the appropriate lines 11 to print the indicated dots. The pattern of dots to print the selected message is given in the lower part of the drawing with the respective rows indicated for printing of specific dots.

Fig. 14 represents a schematic arrangement of more complete details of the circuitry described in a limited way in Fig. 12. In view of the complexity of the circuits, it is impossible to place the complete circuitry on one sheet of the size suitable for patents, so the sections are broken down into sections A, B, C and D. A—B and B—C represent lines connecting the circuits of A and B and of B and C, respectively.

Figs. 15a and 15b, when combined, with Fig. 15b (A-2) positioned on the right of Fig. 15a and aligned in accordance with common designations in the two Figures, shows the complete circuitry for Section A of Fig. 14. This part of the circuit is for device code selection, control signals to the microcomputer, the BCD decoder and the I/O device selection.

Figs. 16a, 16b and 16c, when combined, with Fig. 16b at the right of and aligned with Fig. 16a, and Fig. 16c at the right of and aligned with Fig. 16b, shows the circuitry of Section B. This circuit controls the horizontal dot pattern selection.

Fig. 17 shows the circuitry for Section C which controls the column group selection.

Figs. 18a and 18b together show the circuitry for Section D which controls the motor for advancing and positioning the paper. The end of the paper and improper alignment activates an alarm by improper registry of notches cut at a lateral edge of the paper. Fig. 18b is positioned to

the right of and aligned with Fig. 18a.

In Fig. 15a, the data bus of the computer is shown at the left. This data bus acts as a parallel transfer point getting and receiving information from the input/output (I/O) devices.

The computer, via device codes, selects which input or output devices it will need for any given operation. If a print command is to be given, it will select the logic necessary for this.

In Fig. 15b the BCD decoder translates binary language into digital information and the I/O (Input/Output) device selector operates similarly to the device code select.

In Fig. 16a, the microcomputer feeds ASC II information via data bits DB 3, 4, 5, 6, 7 and 8 into U4 for selecting which character (numeral or letter) is to be printed. U5 feeds dot row information for printing each Dot Row selected characters. The inverting drivers 74C902 transmit information from U4 to the character generator in Fig. 16b. The character generator takes computer data and transmits these into an X—Y matrix. This in turn takes the information and sets the character dot by dot that needs to be printed in the horizontal row. The dot pattern select (74C174) acts as a latch and holds onto information for dot selection until the print cycle is completed.

Fig. 16C depicts diode multiplexing for dot selection for each dot row to be printed. The connector connects the printer wiring cable to another connector. While two sections of J1 are positioned separately, they comprise the same connector. Likewise, the two J2's also comprise one connector.

In Fig. 17 the column group select utilizes the same data information going into B-1 (Fig. 16a) for selecting characters and dots to be printed, and through its circuitry selects which column will be energized to allow printing of a specific character.

In Figs. 18a and 18b, the same microcomputer data word (DB6—DB11) activates the motor by phase control as to when and how far (degree steps) to advance the paper. The motor is a multiple phase stepper motor and advances the paper one dot row (.015") at a time. If further advancement is to be made, the one-step advancement routine is repeated as frequently as desired. The positioning of the paper is advantageously controlled by notches cut in a lateral edge of the paper. An optical coupler is positioned to tell when the notch is in the proper position. If the paper runs out as the paper is supposed to be advancing, the light-emitting diode gives a sustained passage of light which activates a status signal that the paper has run out. While this notch system is preferred, a pin-through hole system or optical character recognition may be used for these purposes.

Many of the symbols used in these circuits are standard designations and will be recognized by one skilled in the art. The designations 74C175, 74C32, DS3236N, 2N6124, 74C08, etc. are commercially available units for which the special designation identifies the specifications.

The designation CK refers to clock signals generated by the computer for system timing control. This establishes correct timing for functions controlled by the microcomputer.

While the hand-held unit has been shown connected to the manpack by a cable with connecting lead wires therein, it is also possible to have the signals transmitted from the hand-held unit by radio frequency to activate the desired controls in the manpack, thereby dispensing with the need for a cable.

Moreover, whereas a separate hand-held unit has been described above, it is contemplated that this unit may be attached to or made an integral part of the manpack, possibly as a retractable front portion or as a top section with the appropriate keys thereon. Furthermore the display unit described above may be on the manpack, possibly on the top instead of in the hand-held unit.

Also, instead of a manpack which is strappable to the operator's body, it is contemplated that this may be carried in a case, such as in an attache' case, easily transportable and placed in a convenient position for use.

Instead of the thermal printer described above, the microcomputer circuitry described herein may be used to activate a miniaturized impact printer or dry print electrostatic printer. A solenoid driven pin matrix may be used to generate printout similar to that previously described for the thermal process. However, the thermal method described above is preferred because it lends itself most effectively to light weight and good power efficiency.

While certain features of this invention have been described in detail with respect to various embodiments thereof, it will of course be apparent that other modifications can be made within the spirit and scope of this invention, and it is not intended to limit the invention to the exact details shown above except insofar as they are defined in the following claims.

Claims

1. A portable computing-printing device comprising:

A. an electronic manpack comprising:

1. A microprocessor based computer comprising a data bus connected therein to receive and send information to and control the input/output devices defined hereinbelow, to make calculations and process data and to output such processed data to the printer defined hereinbelow, to a visual display unit and to an electronic storage means;
2. An input means on which digital information is recordable and is retrievable therefrom;
3. An input/output means for receiving and storing information and adapted to retain said information for later retrieval;
4. A printer sub-system connected to receive alpha-numeric information and control

signals from said microprocessor based computer and to print the data received from said microcomputer;

5. Control logic and associated circuitry interfacing the various elements of said microprocessor based computer with the said input and output means, the hereinbelow defined unit and said printer; and

6. A lightweight battery; and

B. a unit having a plurality of keys thereon adapted to enter information into said microprocessor based computer, to recall information from said microprocessor based computer and to direct said device to perform various data processing and printing operatons.

2. The device of claim 1 which also includes a display on which requested information is made visible.

3. The device of claim 1 in which said unit is a hand-held unit.

4. The device of claim 3 in which said hand-held unit includes the display on which requested and instructional information is made visible.

5. The device of claim 1 in which said manpack is adapted to be strapped onto a person's body.

6. The device of claim 1 in which said printer comprises a printhead having a series of columns of minute resistors, said columns being arranged horizontally with respect to each other and each said column comprising a bottom line of said resistors arranged horizontally and above each said resistor in said bottom line there being a row of said resistors arranged vertically, each resistor coming to a point or dot in the same plane as the other said resistors in said printhead and adapted to have current passed therethrough thereby to heat said resistor to an appropriate temperature to release a dot of coloring material from appropriately treated paper placed in contact with said printhead, in which printer said resistors are connected through control logic to a microcomputer which selects the appropriate resistors in each line of said column to which current will be supplied in appropriate sequence and also selects the appropriate sequence of columns in which selected resistors will be supplied current to print appropriate dots to form the message dictated by said microcomputer, in which printer no more than one out of every five columns is selected for the application of current so as to have a minimum drain on said battery.

7. The device of claim 6 in which the columns are activated in the sequence of 1 and 6, 2 and 7, 3 and 8, 4 and 9 and 5 and 10, respectively in a horizontal line of resistors.

8. The device of claim 6 in which each said column comprises five resistors arranged horizontally in each line and seven resistors arranged vertically in each said row.

9. The device of claim 6 in which each said column comprises only one horizontal row of said resistors.

10. The device of claim 8 in which there are five resistors arranged in each said column.

11. The device of claim 6 in which there is included a rotor which advances paper on which dots are to be printed, said rotor being advanced one line at a time in accordance with activation effected by said microcomputer and said dots being printed while said paper is at rest between said advancements.

12. The device of claim 11 in which said one line advancement of paper is effected only after the sequence of heating the selected resistors is completed in the horizontal line positioned for printing on the paper.

13. The device of claim 1 in which said input and input/output means each comprise a magnetic tape.

14. The device of claim 1 in which said input and input/output means each comprise a solid state memory device.

15. The device of claim 1 in which said input and input/output means each comprise printed matter.

16. A method of assimilating utility meter data at the meter locations, comprising, accumulating on an input information electronic storage means customer profile information for a plurality of meter customers, said profile information including the customer identity and account information, placing said input information electronic storage means in a portable computer capable of being manually carried to the site of a given meter, said portable computer having an output information storage means and having the capability of updating, printing and presenting various of said customer profile information for said meter customers before and after receiving current customer profile information, actuating said computer to segregate and to visually present from the customer profile information for a plurality of meter customers stored on said input information electronic storage means at least the meter number and customer identity information of a given meter customer, imposing into said computer the current meter reading of said given meter customer at the site of the meter being read, actuating said computer to calculate the charge for utility usage based upon the previous meter reading and said current meter reading, actuating said computer to print a bill for said meter customer at the site of said meter based upon said calculation and imposing on said output information storage means the updated customer profile information, and depositing said bill at the service address of said given meter customer.

17. The method of claim 16 wherein said aforementioned steps are repeated for all of the customers on said input information storage means.

18. A device for assimilating utility meter data at the meter location, comprising, a portable computer means comprising a computer housing, computer circuitry, input information electronic storage means operatively connected to said computer circuitry, said input information electronic storage means containing customer

profile information for a plurality of meter customers, printout means operatively connected to said computer circuitry, and manual control means for actuating said computer circuitry and for putting raw data into said computer means, said manual control means including a visible message output board connected to said computer circuitry whereby the operator can visually observe certain of the information contained in said computer as said information is composed on an output board, said control means including means for segregating and visually presenting on said output board customer profile information for one meter customer from the customer profile information for a plurality of meter customers stored on said input information electronic storage means.

19. The device of claim 18 wherein said control means is a hand-held control manifold connected to said computer housing by an elongated flexible coupling.

20. The device of claim 18 wherein a shoulder harness is secured to said computer housing for carrying the same.

21. The device of claim 19 wherein a shoulder harness is secured to said computer housing for carrying the same.

22. The device of claim 18 wherein said information storage means are tapes.

23. A portable computing-printing device substantially as herein described with reference to the accompanying drawings.

24. Each and every novel feature herein described.

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